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MEMORANDUM REPORT NO. 1563
MARCH 1964

ELECTRICAL CONDUCTIVITY OF WATER UNDER SHOCK COMPRESSION

Richard E. Yuknavech

RDT & E Project No. 1A013001A039

BALLISTIC RESEARCH LABORATORIES

ABERDEEN PROVING GROUND, MARYLAND

B A L L I S T I C   R E S E A R C H   L A B O R A T O R I E S

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Richard E. Yuknavech

Terminal Ballistics Laboratory

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A B E R D E E N   P R O V I N G   G R O U N D,   M A R Y L A N D

LIST OF SYMBOLS

d_1 - initial thickness of water conductor - cm

d_2 - thickness of water conductor under shock compression - cm

u - shock wave particle velocity - cm/μsec

A - cross-sectional area of water conductor - cm^2

C - circuit capacitance - μf

E_o - voltage across R_T when $R_x = 0$ - v

E_x - voltage across R_T when $R_x > 0$ - v

L - length of water conductor - cm

R_i - circuit resistance $\left[R_p\,(R_s + R_T)\right] / \left[R_s + R_T + R_p\right]$ - ohms

R_p - circuit resistance - ohms

R_s - circuit resistance - ohms

R_T - terminating resistance for coaxial cable - ohms

R_x - resistance of water in conductivity cell - ohms

T - temperature - ^oK

U - shock-front velocity - cm/μsec

V - supply voltage - v

σ - conductivity - $ohm^{-1}\ cm^{-1}$

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MEMORANDUM REPORT NO. 1563

REYuknavech/mts
Aberdeen Proving Ground, Md.
March 1964

ELECTRICAL CONDUCTIVITY OF WATER UNDER SHOCK COMPRESSION

ABSTRACT

The electrical conductivity of water under shock compression has been measured from 40 to 194 kilobars. Measurements were made on a 0.051 cm x 0.254 cm x 0.762 cm volume of water contained in a polyethylene conductivity cell. The results are in agreement with those of David and Hamann; and Brish, Tarasov and Tsukerman who used a different technique. It was found that the conductivity could be represented by the equation,

$$\sigma = 133 \exp (-5.52 \times 10^3/T),$$

where σ is the conductivity in $\text{ohm}^{-1}\ \text{cm}^{-1}$ and T is the shock temperature in degrees Kelvin as calculated for water by Rice and Walsh.

INTRODUCTION

In a recent investigation, H. G. David and S. D. Hamann[1] found that the conductivity of distilled water increases by several orders of magnitude at high shock pressures. A single value for the conductivity of water obtained at a shock pressure of 98 kilobars by Brish, Tarasov and Tsukerman[2] agreed well with the work of David and Hamann. Cook, Collins, Keyes and Olson in a later work[3] observed similar behavior, but reported significant quantitative disagreement with the earlier experiments. The applicability of these data to certain experiments in shock polarization being conducted at the Ballistic Research Laboratories prompted a further investigation of water conductivity under shock compression, with two major aims. First, it was necessary to determine which of the two existing sets of data was more reliable in the pressure range covered (David and Hamann: 33 - 127 kilobars; Cook, Collins, Keyes and Olson: 90 - 148 kilobars). Second, it was necessary to extend the conductivity measurements to 200 kilobars to completely cover the pressure range used in shock-induced polarization studies.

PROCEDURE

Resistance measurements were made on small, rectangular water-filled cells during the passage of high-pressure shock waves. These measurements were then reduced to specific conductivity values, using the known geometry of the cell. Figure 1 shows the experimental setup consisting of a polyethylene block with a groove, 0.254 cm wide and 0.051 cm deep, cut in one face. Gold-foil electrodes, 0.0025 cm thick, were laid in the groove and soldered to copper bus-bar leads. The block was placed face down on a sheet of 0.16 cm polyethylene and the entire assembly was clamped to a metal buffer plate. A rectangular cell of accurately known dimensions was thus formed between the polyethylene block and sheet. Before the test, the cell was filled by flowing distilled water through the filling tubes in the polyethylene block. Precautions were taken to prevent trapped air.

The explosive consisted of a TNT-Composition B plane-wave lens four inches in diameter, used with various base charges - TNT, Composition B or 9404.

Two techniques were used to produce the shock in the water. With the first technique, the buffer plate was mounted directly on the explosive (Figure 1). By changing the explosive base charge or the buffer material, various pressures were obtained, ranging from 47 kilobars (in water) with TNT and a brass buffer to 167 kilobars with 9404 and a magnesium buffer.

The second technique involved "throwing" one plate at another plate on which the cell was mounted, as shown in Figure 2. The thrown plate accelerated through approximately 1.9 cm of travel before impacting the target plate, and a short pressure pulse of high intensity resulted.

The resulting pressure in each test was measured by means of several pins or probes placed in a propane atmosphere at various measured distances above the free surface of the buffer plate. The arrival time of the free surface at each probe was read from an oscilloscope, and the free surface velocity of the buffer material was determined. According to a well-known approximation, the free surface velocity is twice the particle velocity behind the incident shock. The peak pressure in the water was obtained from the particle velocity in the buffer plate by the usual graphic method using the Hugoniot curves for the buffer material and water.

The rapidly varying resistance of the water was measured with an oscilloscope using the circuit shown in Figure 3a, where R_x represents the resistance of the water in the cell, R_T is the terminal resistor appropriate to the coaxial cable and R_p and R_s are circuit components. The supply voltage, V, was 45 volts. Before the test, the resistance, R_1, between points A and B in Figure 3 was measured. When the switch across the electrodes was closed momentarily, R_x was shorted out and an oscilloscope record was obtained (Figure 4a) having a peak voltage, E_o. When the explosive was detonated and the shock front passed through the cell, trace 4b appeared with peak voltage, E_x. By reducing the circuit of Figure 3a to the equivalent circuit in Figure 3b, it can be seen that

$$R_x = R_1 \left[(E_o/E_x) - 1 \right]. \qquad (1)$$

Equation 1 assumes that the amplification of the oscilloscope, the supply voltage and the value of R_1 remain constant for both readings.

Using the known dimensions of the conducting gap and the measured value of R_x, the conductivity of the water under shock was obtained from the basic equation for the resistance of a uniform conductor

$$\sigma = L/R_x A, \qquad (2)$$

where σ is the conductivity; L is the length of the conductor; and A is the cross-sectional area of the conductor. First, however, the compression of the water, which at these pressures is considerable, must be taken into account. If d_1 is the measured static depth of the conducting gap and d_2 is the depth at the instant of peak conductivity (assumed to occur as the shock front has just traversed the gap), the following formula can be derived

$$d_2 = d_1(U-u)/U \tag{3}$$

where U and u are; the shock velocity and particle velocity of water at the test pressure, respectively.

RESULTS

Table 1 is a complete summary of results. These values of conductivity vs. pressure have been plotted in Figure 5, which also includes the results of David and Hamann and of Cook, Collins, Keyes and Olson. The pressure-conductivity relationship is fairly well defined, despite the presence of some scatter, and agrees well with the values reported by David and Hamann.

The conductivity measurements are considered free from any large errors. Referring to Equations 1 and 2, the dimensions of the gap are measured to a high degree of accuracy, and R_1 is measured immediately before each test with a sensitive bridge. Thus, the greatest chance of error lies in the uncertainty in the measurement of E_o/E_x. It should be noted from Equation 1 that if $R_1 = R_x$ (approximately), the calculated value of R_x is relatively insensitive to small errors in the measurement of E_o/E_x. For this reason, each test was designed around an estimated value of R_x obtained by extrapolation from the results of preceding tests. By changing R_s, R_p, and R_T, R_1 could be made approximately equal to the expected R_x. Because of stray inductance in the circuit, the bypass capacitor C had to be changed, usually by trial-and-error, to provide the longest time constant in the circuit consistent with a clean, sharp break at the top of the conductivity trace. In a static test using an electrolytic solution of known conductivity, this method yielded a value for the conductivity that differed from the accepted value by less than 1%.

There, however, is some uncertainty in the pressure measurement. Apart from the usual chance of random error, there is some question as to the exact pressure in the water, since the pressure in such a small volume of fluid should be influenced to some (unknown) extent by the pressure in the surrounding insulator. Because of the excellent impedance match between the two substances, this correction should not be more than 1 or 2 kilobars.

A word should be said concerning the two data points at 172 kilobars, which were obtained by a plate impact technique similar to that used in the test at 194 kilobars. A thrown plate is expected to produce a profile with a relatively flat top followed by a rapid decline in pressure[4]. Figure 6a, obtained in the 194 kilobar test, fits this description. The two tests at 172 kilobars resulted in profiles like that shown in Figure 6b, in which several shocks of decreasing intensity are evident. The presence of several shocks shows that the plate has spalled in such a way as to produce multiple impacts. Because of the long time interval between the first and second impacts, it was decided that the conductivity indicated by the first peak in Figure 6b, together with the measured pressure, constitutes a reliable measurement of the conductivity of water at that pressure.

The uncertain point at 40 kilobars in Figure 5 was the result of a test using a laminated brass and aluminum buffer plate (Figure 7). The resulting trace seems to show a relatively weak shock being overtaken by a stronger one. This had been observed in some previous experiences with laminated buffers, and is the result of a reinforcement phenomenon involving reflected shocks within the buffer. The assembly shown in Figure 7 was designed to eliminate problems due to shock reinforcement, so there is no ready explanation for the form of this trace. It was thought best to assume nothing, but to calculate the conductivity represented by each peak and to report the measurement as uncertain, but probably falling between the two measured values.

CONCLUSIONS

Ionic conductivity is related to absolute temperature by an equation of the form: $\exp(-b/T)$. Given an initial temperature of a substance, it is possible to calculate a shock temperature for every point on the Hugoniot of that substance. M. H. Rice and J. M. Walsh[5] have done this for water along the Hugoniot centered at 20°C (293°K) and 1 atmosphere. Figure 8 shows $\ln \sigma$ as a function of

T^{-1}, where σ is the measured conductivity and T is the calculated shock temperature. The following equation was obtained from a linear least squares fit to this data:

$$\sigma = 133 \exp\left(-5.52 \times 10^3/T\right). \tag{4}$$

This equation is also represented by the solid line in Figure 5. As yet there is no physical interpretation for the values of the constants.

The shock temperatures computed by Rice and Walsh were assumed to be applicable to the conductivity experiments and were used to evaluate the constants in Equation 4. This is correct if the temperature in polyethylene is equal to that in water at any given pressure, or if the temperature in the water is not significantly influenced by the temperature in the polyethylene. The experimental set-up described by David and Hamann is such that the water temperature could not have been influenced to any noticeable extent by the surrounding material. The excellent agreement between the polyethylene cell data and the data of David and Hamann suggests that, if the conductivity phenomenon is temperature-dependent, the water temperatures must have been the same. This justified the use of the Rice-Walsh data in evaluating the constants.

TABLE I

Experimental data for the conductivity of water as a function of shock pressure. Temperatures at the different shock pressures are from calculations by M. H. Rice and J. M. Walsh[5].

Pressure (H_2O) (kilobars)	Conductivity ($ohms^{-1}cm^{-1}$)	Temperature ($^{\circ}K$)
40	7×10^{-4} 1.79×10^{-3}	468
47	0.011	506
100	0.186	844
107	0.26	890
122	0.56	1000
140	0.79	1128
167	1.83	1330
172	2.25	1365
172	2.70	1365
194	4.24	1525

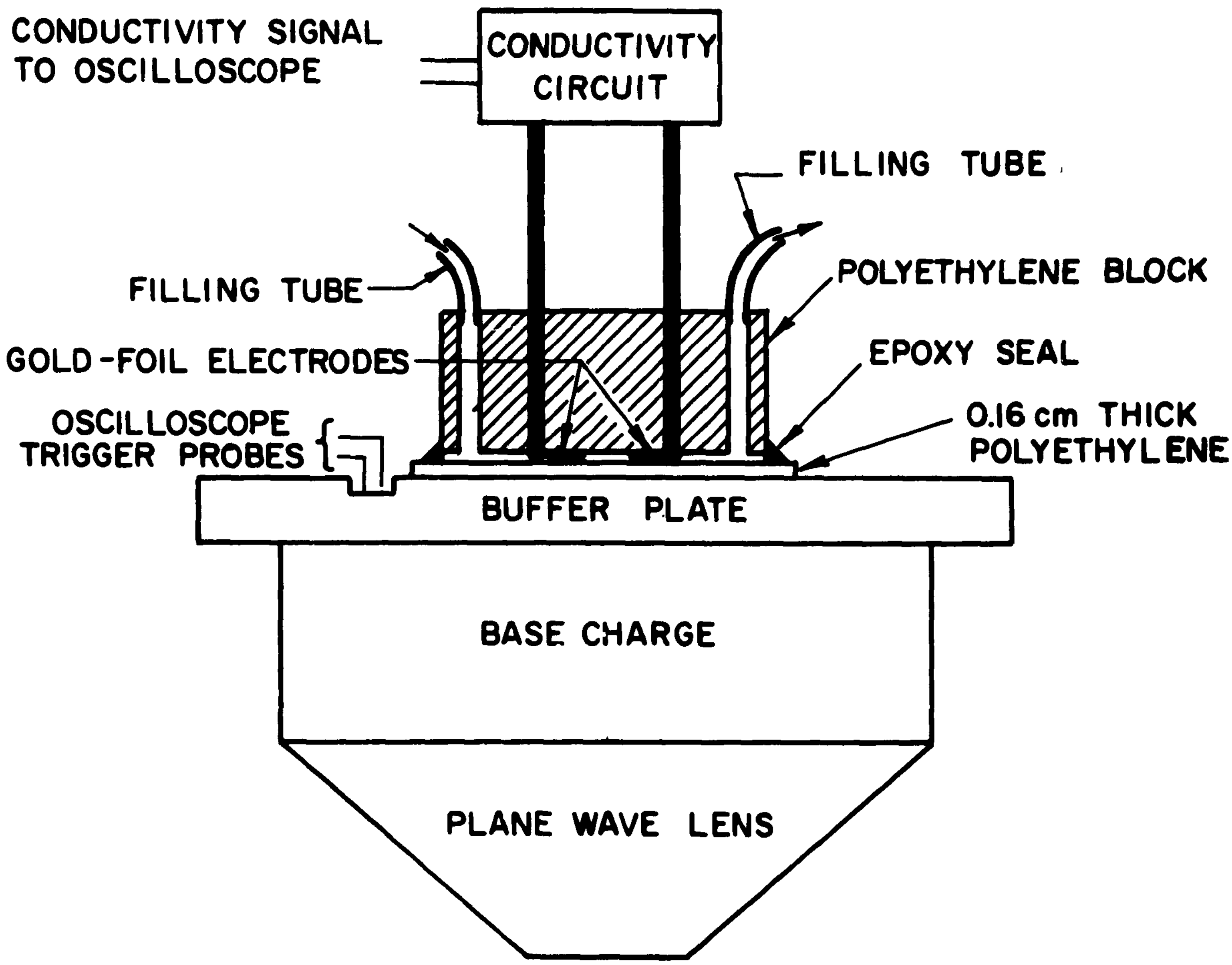

Figure 1. Experimental setup for measuring the electrical conductivity of water under shock compression.

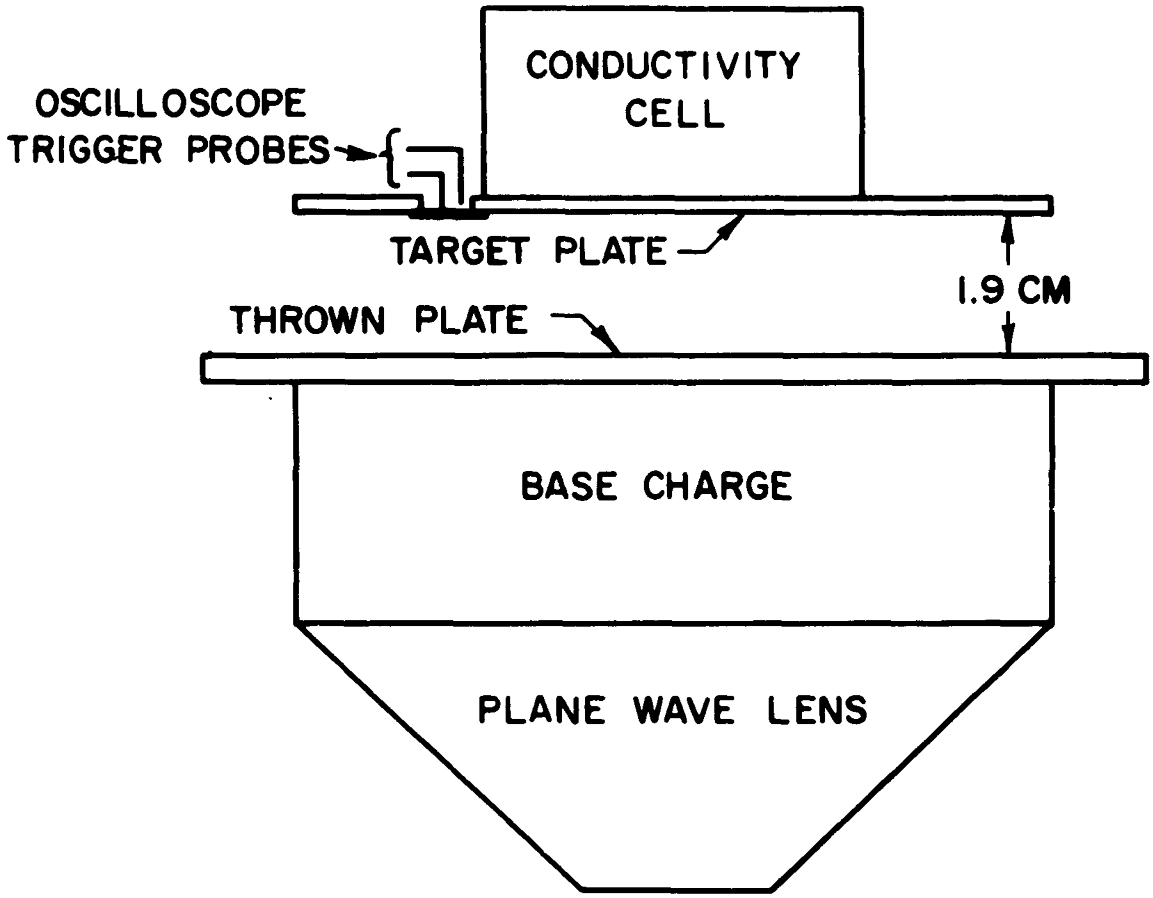

Figure 2. Experimental arrangement for plate impact tests.

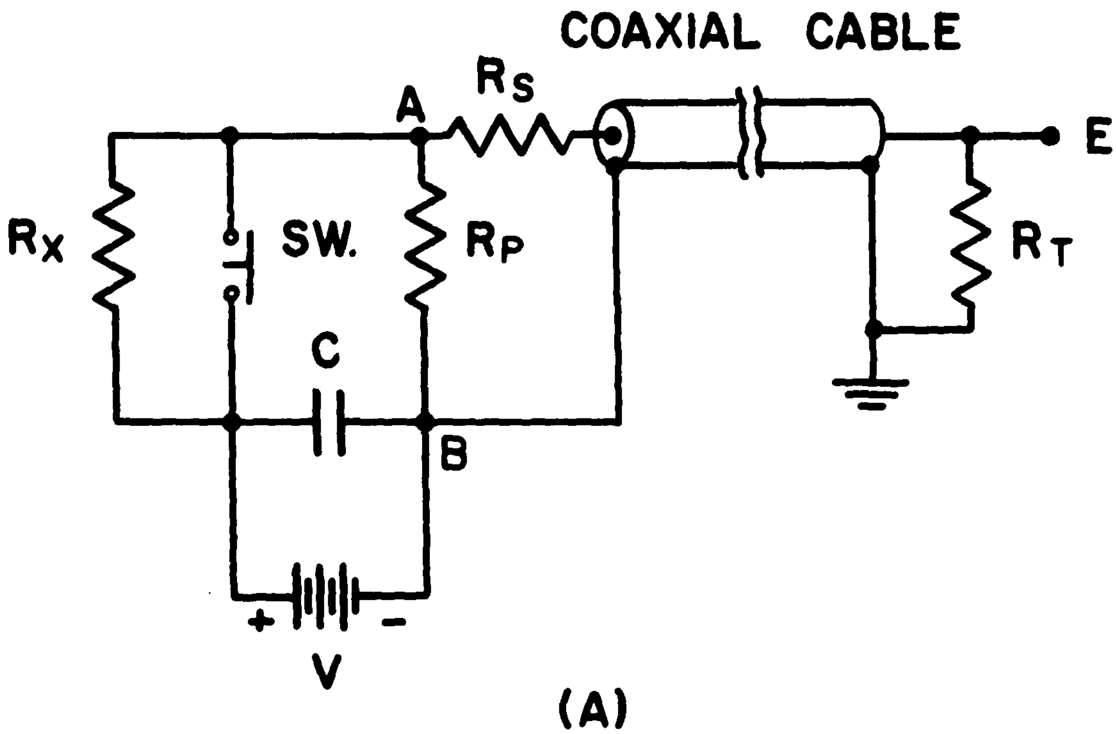

Figure 3. (a) Circuit for water conductivity measurements.

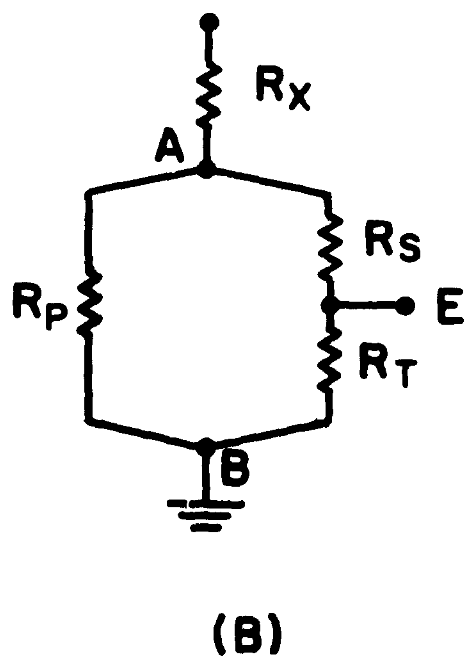

Figure 3. (b) Equivalent circuit.

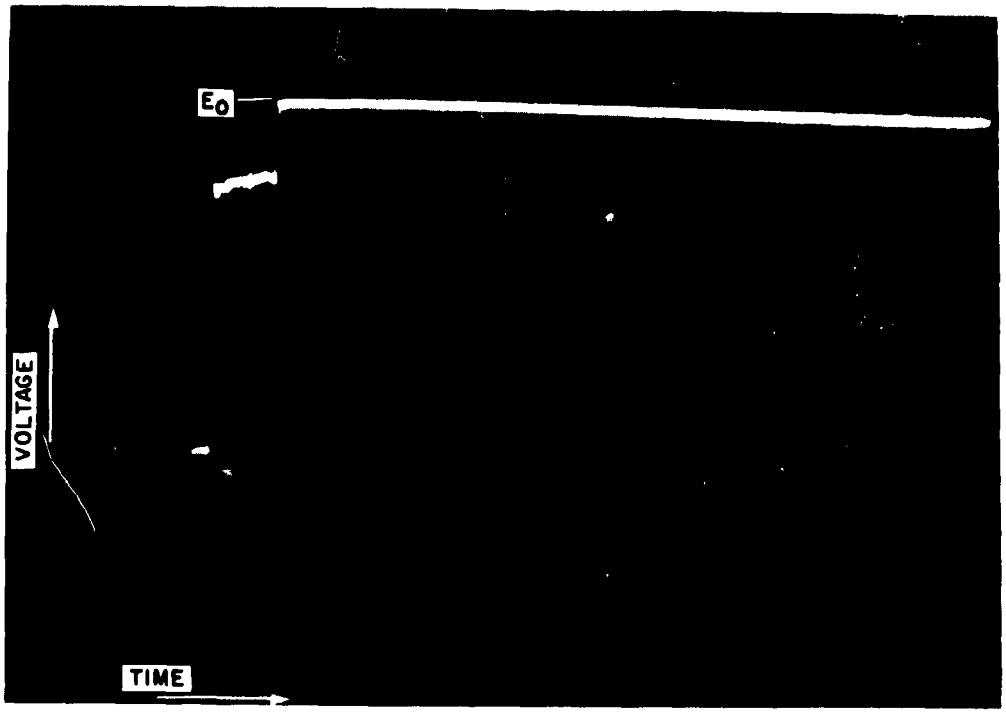

Figure 4. (a) Conductivity circuit calibration trace. Break during rise is switch noise. Sweep speed 2 cm/μsec.

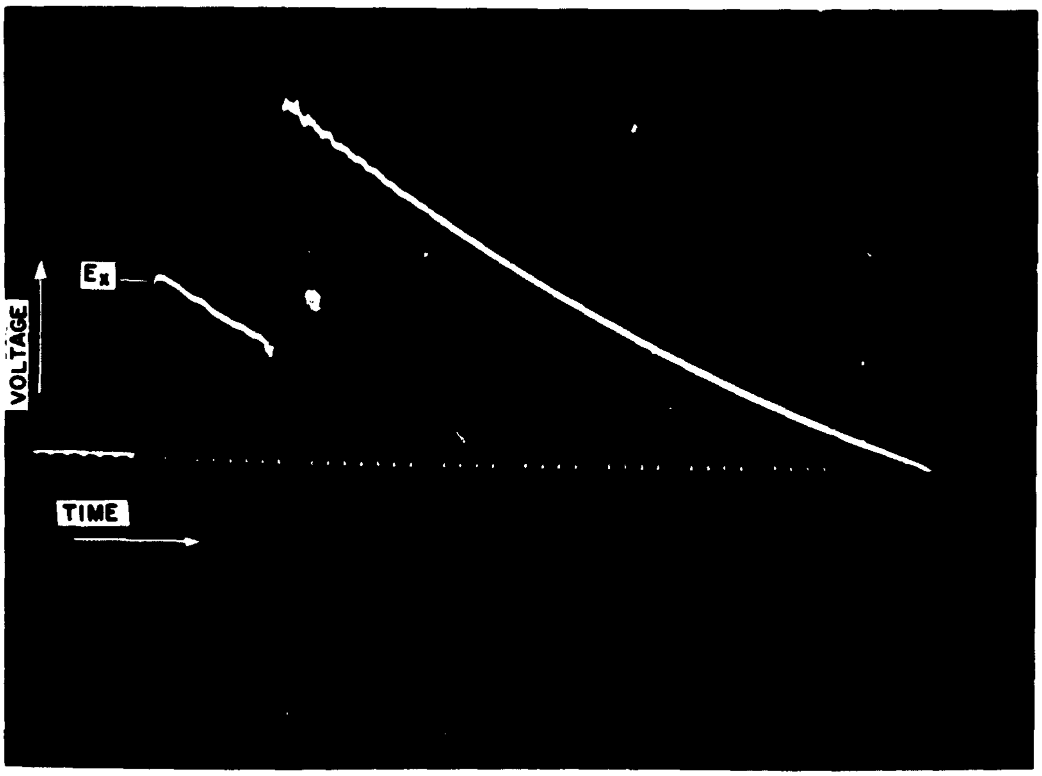

Figure 4. (b) Oscillogram of typical conductivity test with the buffer in contact with the explosive (see Fig. 1). Second voltage peak indicates shorting of electrodes by buffer plate. Time marks at 0.1 μsec intervals.

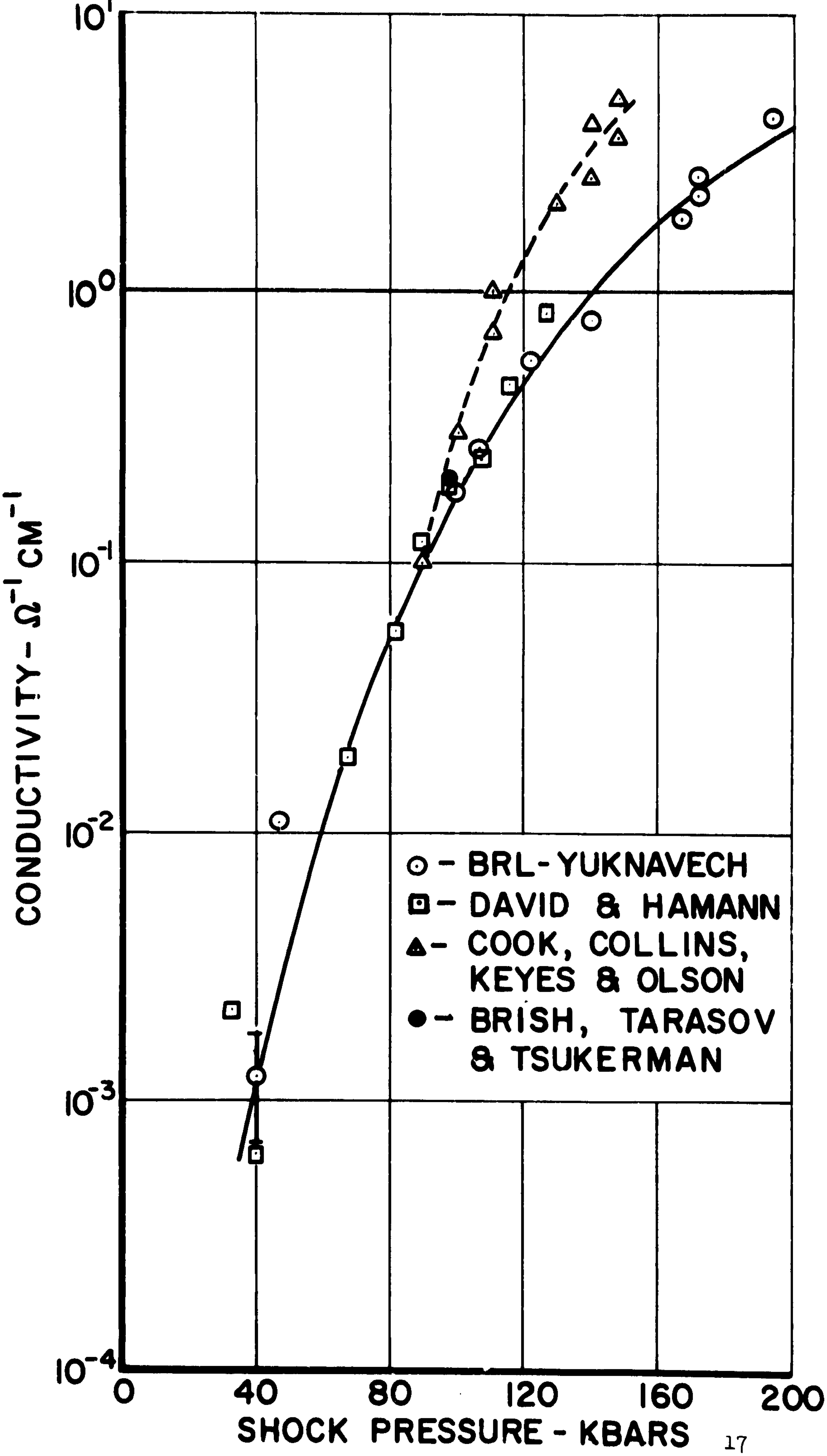

Figure 5. Conductivity of water as a function of shock pressure. The solid curve was computed from $\sigma = 133 \exp(-5.52 \times 10^3/T)$.

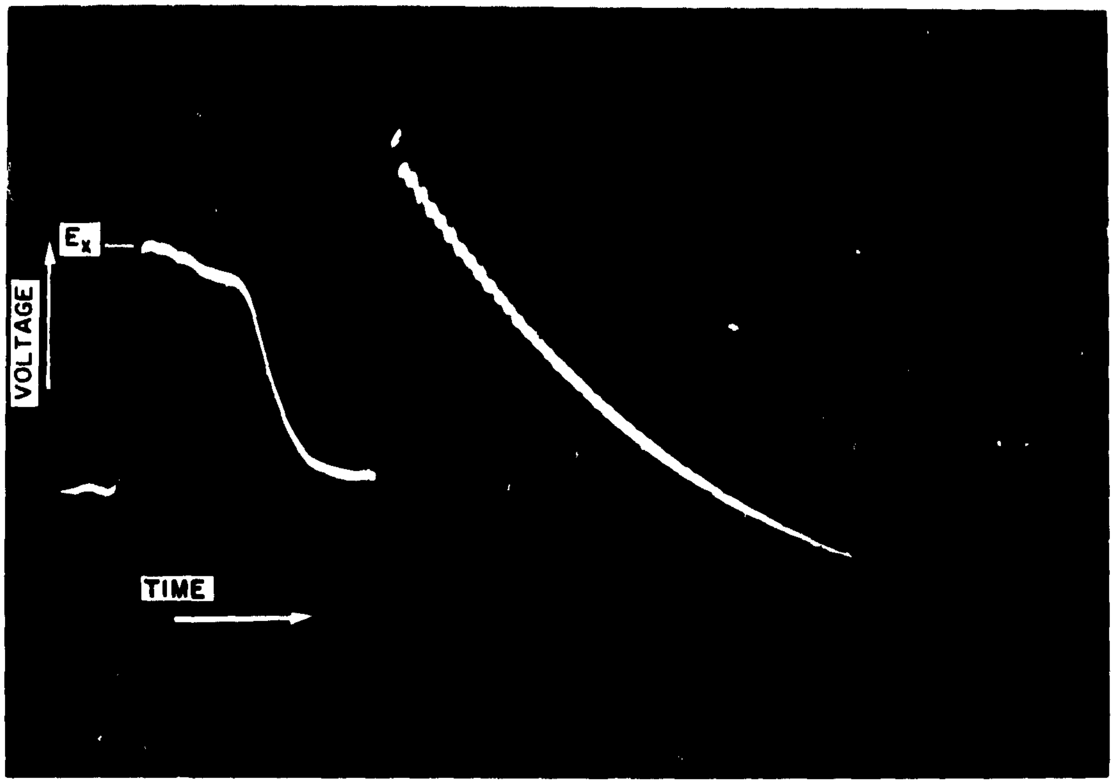

Figure 6. (a) Oscillogram of typical plate impact test. Time marks at 0.1 μsec intervals.

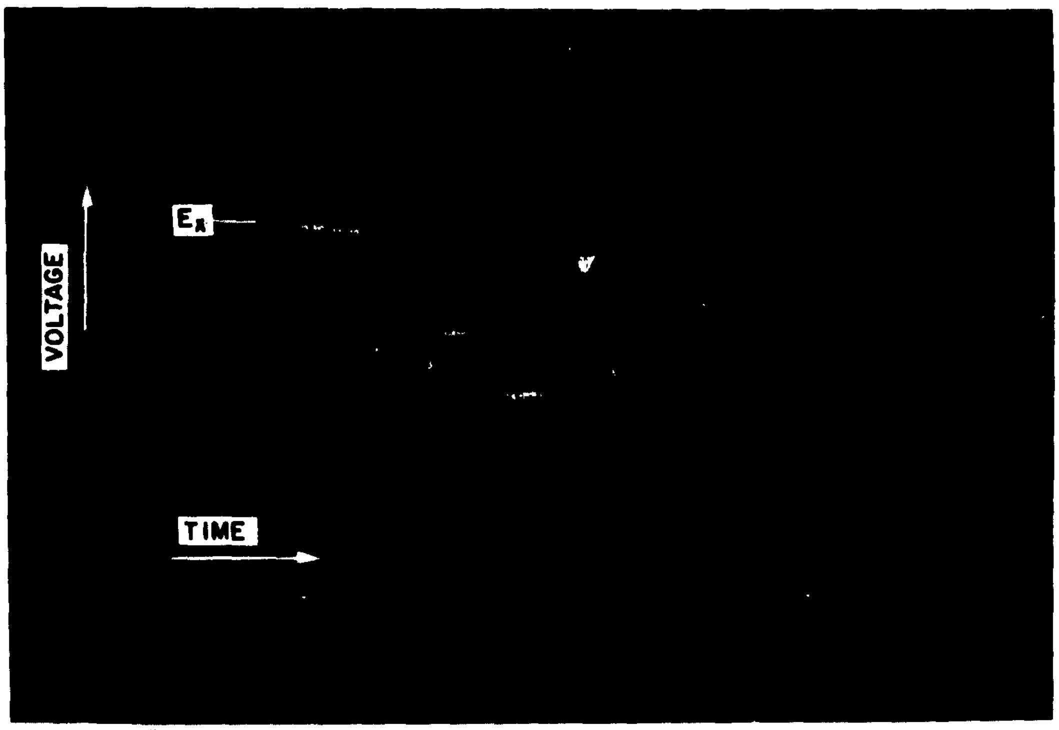

Figure 6. (b) Oscillogram of plate impact test with suspected spalling. Time marks at 0.1 μsec intervals.

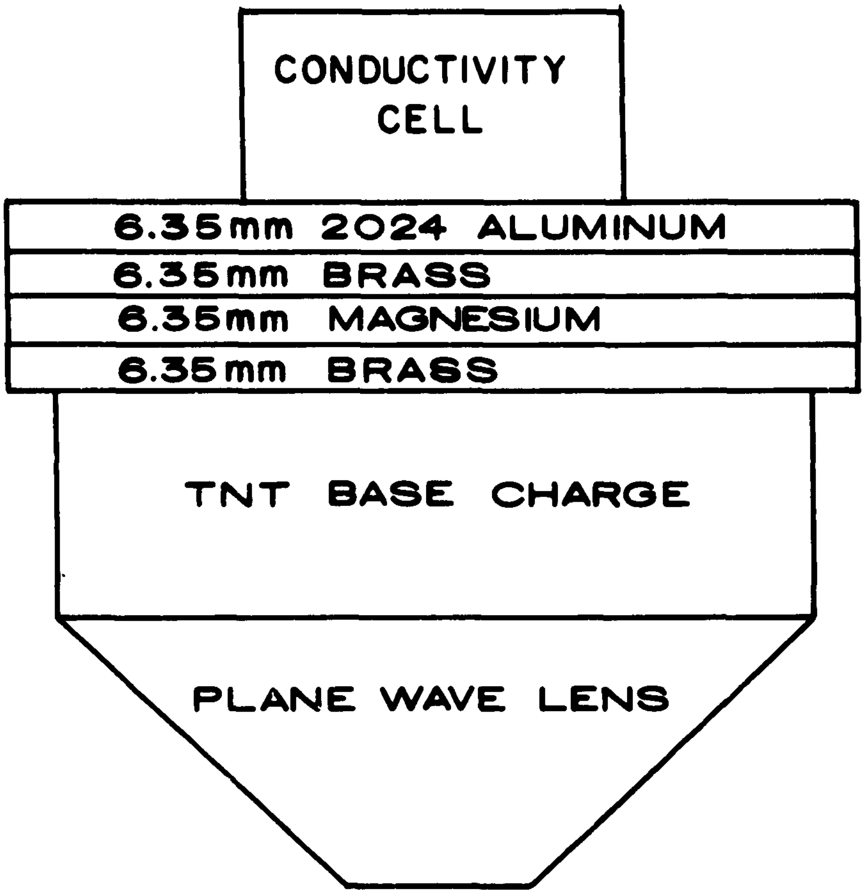

Figure 7. Laminated buffer assembly used to obtain low pressure by means of impedance mismatch between laminations.

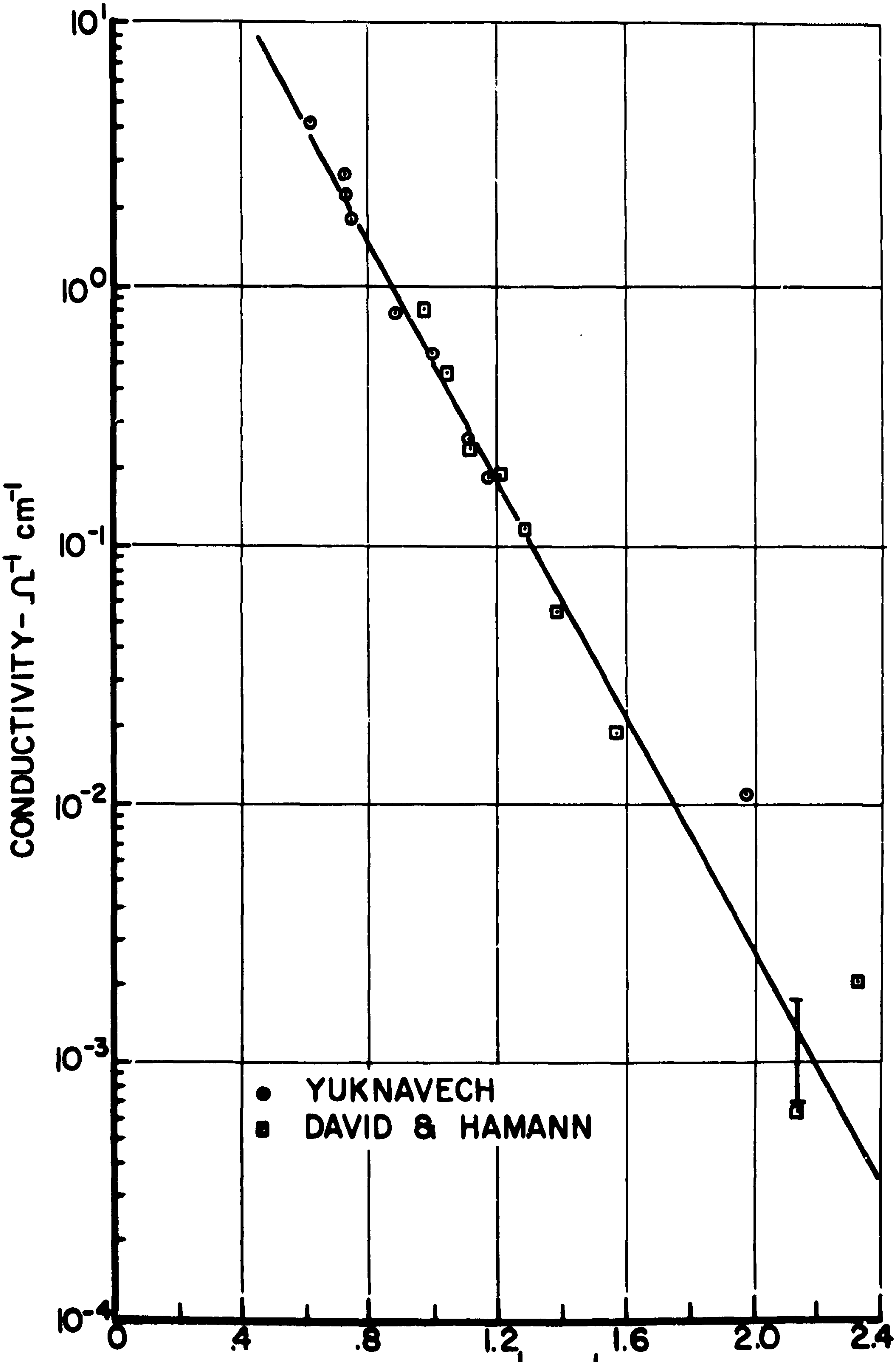

Figure 8. Conductivity, σ, of water as a function of T^{-1}, where T is the calculated shock temperature. The line is a linear least squares fit to the data, and is represented by $\sigma = 133 \exp(-5.52 \times 10^3/T)$.

REFERENCES

1. David, H. G. and Hamann, S. D. Trans. Faraday Soc. 55, 72-78, 1959.

2. Brish, A. A., Tarasov, M. S. and Tsukerman, V. A. Soviet Phys. - JETP 11, 15-17, July 1960 (English Translation).

3. Cook, Collins, Keyes and Olson. Investigation of Electrical Conduction Mechanism Occurring in Shock Loaded Semi-Conductors. Quarterly Progress Report, Contract N123 (60530) 25906-A, Institute of Metals and Explosives Research, U. of Utah, Salt Lake City, Utah, 30 June 1962.

4. Fowles, G. R. J. Appl. Phys. 31, 655-661, April 1960.

5. Rice, M. H. and Walsh, J. M. J. Chem. Phys. 26, 824-830, April 1957.

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RDT & E Project No. 1A013001A039

UNCLASSIFIED Report

Electrical Conductivity - Water
Shock Compression - Effects

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Electrical Conductivity - Water
Shock Compression - Effects

The electrical conductivity of water under shock compression has been measured from 40 to 194 kilobars. Measurements were made on a 0.051 cm x 0.254 cm x 0.762 cm volume of water contained in a polyethylene conductivity cell. The results are in agreement with those of David and Hamann; and Brish, Tarasov and Tsukerman who used a different technique. It was found that the conductivity could be represented by the equation,

$$\sigma = 133 \exp(-5.52 \times 10^3/T),$$

where σ is the conductivity in $ohm^{-1}\ cm^{-1}$ and T is the shock temperature in degrees Kelvin as calculated for water by Rice and Walsh.